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Turgidity in Mycelia

BY CARLTON C. CURTIS

Although the question of the mechanics of growth has been canvassed since the time of Nägeli by so many writers as Schmitz, Krabbe, Wortmann, Strasburger, Eschenhagen, Askenacy, Zacharias, Noll, Schwandener, Strange, Reinhardt, Hegler, Pfeffer, True, and Copeland, we must still agree with Krabbe, that an acceptable theory of growth does not exist. Especially are we indebted to the researches of Pfeffer as set forth in the "Druck und Arbeitsleistung durch wachsende Pflanzen" and the second part of "Studien zur Energetik der Pflanzen" for an elucidation of the various phenomena associated with growth. Especial attention is called by Pfeffer to the fact that the mechanics of growth may not only vary in different cases, but that all growth is dependent upon the coöperation of many factors. Consequently the retarding or quickening of the rate of growth may not be ascribed to any one agency. So in regard to turgidity its action may be more than counter-balanced by other forces, and we find no "fixed relation between the turgor force, stretching of membrane, and rate of growth." The present work was undertaken to determine just what relation turgidity sustains to growth when all other conditions, so far as possible, are kept constant and only known variants are introduced. The hyphae of fungi were used for these observations. They were grown in nutrient solutions of varying degrees of concentration and transferred to solutions of higher or lower concentration. In this way wide variation of turgidity was created, and as the moment of the renewal of growth in the hyphae

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could easily be detected, it was possible to test the turgor force at the instant of the recovery from the effect of the change of substratum. The basis of all media used in the experiments which are here recorded was a nourishing solution composed of 3% cane sugar, .5% peptone and .5% beef extract, and from this were made solutions containing various gram-molecule percentages of potassium nitrate. By this means the plants were always afforded a constant nourishment and the effects of the introduction of a known factor, potassium nitrate, could readily be determined. In many respects the hyphae of the lower fungi are especially adapted to this character of work since they are easily cultivated and handled in microscopic examinations, and possess, to a marvelous degree, adaptability to varying degrees of concentration without injurious results, and are so simple in structure that changes of culture media produce immediate reactions. Many will grow in a saturated potassium nitrate solution, about 23%, and some will endure a transfer from relatively strong to zero solutions without bursting. The suitableness of these plants for measuring the turgor force is more apparent when we consider that Pfeffer has determined that in an artificial cell a 1% potassium nitrate solution produced a pressure 175.8 cm. of mercury, and that this estimate is low since the precipitation membrane is somewhat permeable for potassium nitrate.

It was found impossible to study the behavior of the mycelia in gelatine or agar since these media not only dissolve at relatively low concentrations of the substratum, but they are also objectionable as being somewhat unstable and permitting a rather slow and gradual penetration of the various culture solutions. Gypsum proved a fairly satisfactory means of fixing the spores for germination and subsequent study. The powdered gypsum was mixed into a paste with water, and to this mass the spores were added. The mass was then readily pressed out into a thin plate between glass slides, and hardens in a few minutes. These thin plates, however, were somewhat difficult to fasten to the slides, and are liable to break during an experiment. So attempts were made to germinate the spores in floss silk and strands of cotton fibers fastened to the cover glass with drops of balsam, and this led to a very simple and practical culture method. The spores were fastened to the

cover glass with a film of dilute gelatine and covered with a narrow strip of silk paper or any thin unsized paper about 5 mm. long and 1 mm. wide. Each end of this paper had been previously touched with melted shellac so that a drop adhered to it. By applying a hot rod over the drop of shellac it is melted, fastening the paper firmly to the cover glass. In this way the paper is spread out smoothly over the spores, holding them firmly on the glass. The spores will germinate and push out from under the strip of paper and the mount can be handled without fear of destroying the hyphae, readily changed from one fluid to another and the growth studied in a hanging drop with ease. Furthermore the same hyphae can be observed during the entire experiment, and any error that might arise from a change from one filament to another can be avoided. Every precaution was taken to secure uniform external conditions. Repeated tests during the day showed that the ordinary variations of temperature produced no effect on the turgor force and rarely was there a variation of over one and a-half degrees during the majority of the experiments. The work prosecuted in the summer, however, was subject to a much more considerable range of variation than in the winter.

In regard to illumination, the alternation of light and darkness and different degrees of light intensity gave no different results from those obtained when the plants were grown in the dark room and received illumination only from the mirror of the microscope for a few moments at the time of the observations. For the purpose of uniformity all the cultures and examinations were made under the same conditions so far as possible and the greater part of the experiments were conducted under exceptionally uniform conditions.

The spores used were always taken from recent cultures since they produced plants of more uniform vigor. But even with this precaution here was presented the most serious difficulty in the work. For, having sown a few spores on a cover glass, not only do some fail to germinate but some are very slow to grow and others show a great vigor. Again, some will produce almost from the start a branched series of filaments and others will develop lateral branchlets only after extended growth. Now it is evident that

these variations are the expression of different conditions and forces existing in the plant and if the measurement of the turgidity is to be of any value it must be determined from plants presenting a uniform vigor of growth. It was often a difficult task to find in successive cultures hyphae showing the same vigor and condition of growth. The fluctuations in the rate of growth due in some cases to preparations for branching on the part of the plant and in other instances due to no apparent cause, rendered it difficult to select plants in the various experiments that would give real comparative values. This difficulty presented itself again when changes from one media to another had been made. For perhaps the hyphae under observation would not respond to the change for half an hour or longer after others had showed the desired effects. The question then presents itself, How much weight can be given to any measurement in such an instance? Obviously such conditions necessitated repetition of experiments many times to arrive at any conclusions.

To secure the most uniform conditions possible the spores, prepared as above described, were germinated in closed Stender dishes, 8 × 4½ cm., the cover glasses being just covered with the fluid. By this means the spores and germinating plants were exposed to the same atmospheric conditions and always had the same volume of nutrient solution to draw upon, while the solution could not materially absorb or evaporate water—factors of vital importance to the success of the work. By removing the covers of the dishes the cultures could readily be examined on the table of the microscope without danger of disturbing them and when found ready for use the cover glass was removed, carefully freed of the fluid with a blotter save about the hyphae and studied in a hanging drop over a damp chamber. In all experiments the damp chamber (made from a piece of thick cardboard) was placed in a Stender dish, the bottom of which was covered with the same solution as used in the hanging drop. I found this to be of the greatest importance for if there was any considerable variation in the concentration of the hanging drop and the fluid of the damp chamber a very considerable change would result in the concentration of the hanging drop producing very material alterations in the rate of growth and turgor. In this way the damp

chamber was also constantly kept saturated and the drying up of the drop prevented. Having selected from the drop culture a plant for testing, the cover glass was quickly freed from all fluid possible by means of the feathered edge of blotting paper, washed in the solution to which it is to be transferred, placed in a Stender dish and covered with the fluid after the manner described for germinating the spores. This insured an immediate action of the substratum and, owing to the relatively large volume of the substratum, it is not subject to any material change through the metabolism of the plant or the diffusion of any portion of the previously used culture fluid which might still cling to the cover glass through the capillarity of the paper or mycelia. Of course when the period of recovery from a change was short it was only necessary to wash the culture in the fluid to which it was to be transferred and mount it on the damp chamber in a fresh drop of this fluid. Knowing, by experiment, approximately when the plants would recover from the change of substratum, the cover glass was wiped dry, leaving a hanging drop on the mycelia, and placed on the damp chamber.

It was possible to determine the exact moment of renewal of growth after a change of substratum owing to the fact that this was announced by the enlargement of the apices of the hyphae, which were very constant and characteristic features. The turgidity of the plant was tested at this moment, although the swelling would go on for varying lengths of time, amounting in some cases to 10 or 15 minutes before a branch or usually branches would appear that increased the length of the hyphae.

Every precaution possible was exercised to secure accurate measurements of the turgidity. With the first sign of the enlargement of the apex the cover glass was freed of the fluid and immersed in the plasmolyzing fluid, isotonic solutions of sodium nitrate being used. A stock of the various percentages required was made up and used through all the experiments, and fresh volumes were taken from these jars for each experiment. The turgor force of a plant recovering from a change was always compared at the same time with the turgor force of a plant that had germinated and grown in the same strength of fluid to which the trial plant had been changed. In this way two plants in the same condition of development were compared, the one with the turgor

normal to the solution in which it was growing and the other had so adjusted its turgor to this same concentration of the substratum that growth became possible. It was found, after trying a certain percentage of the plasmolyzing solution on a plant without producing plasmolysis that any subsequent tests with higher strengths were unreliable, giving too high values to the turgor force. This is doubtless due to the fact that a solution too weak to plasmolyze does cause a concentration of the cell contents as is seen from the reduced size of the hyphae. One of the surprising features of the work was the variability of the turgidity, so that it was not at all safe to rely upon any determination of the turgor force of plants grown in a given concentration as a basis for comparison of plants changed to this concentration; as mentioned above, a test plant was always used as a check upon all measurements. This variability of the turgidity was also observed while working with Prof. Pfeffer, for whose courtesy in extending to me the privileges of the laboratory, I wish to return thanks.

Some of the results of the experiments upon *Mucor* will be found in the first table. The first column shows the average temperature of the day on which the experiment was made. In the second column is the record of the changes of the substratum; thus 0–4 indicates that the spores were grown in a simple nutrient solution and transferred to a nutrient solution containing 4% KNO_3. The third column shows the time elapsing after the change before growth appeared. For example, in the first experiment the culture was transferred at 8.10 to a 4% KNO_3 nutrient solution. Growth ceased till 10.13, or growth was renewed after two hours and three minutes. The turgidity in percentages of $NaNO_3$ is found in the fourth column. A — after a number indicates that this percentage did not plasmolyze as perfectly as in the case of the plant used as a check and for comparison. A + signifies the reverse condition, and that the plasmolysis was more severe than in the check plant. N. P. indicates that the percentage used failed to plasmolyze at all the hypha. The last column includes the measurements of the turgidity of the plants used as checks and for comparison with the plant subject to the change of substratum. Considering the second experiment, 18 in the fifth column indicates that this was the turgor force of plants germin-

ated and grown in a 4% KNO_3 nourishing solution on the day of the experiment, while in the fourth column 18 — records the fact that this same strength of the plasmolyzing solution did not plasmolyze as strongly the plant that was subjected to the change of concentration.

I.

1	2	3	4	5
21.	0–4	2.3	17 n. p.	18
21 5	"	2.15	18—	18
22.	"	1.43	18	18
21.5	"	1.35	18—	18
22.	"	1.45	18+	18
22.6	"	.59	20+	20
22.6	"	1.33	20+	20
22.6	"	1.25	20+	20
21.5	"	1.50	18—	18
20.8	"	.45	18	18

These are a few illustrations taken from many experiments to give an idea of the range of variation in different cases. The interesting feature appears in columns 4 and 5. All the measurements show practically the same result, that before growth is renewed the turgor force has become equal to the turgor of plants growing normally in this solution. Scores of experiments were performed testing the plants as in the first experiment with a lowei

II.

1	2	3	4	5
22.	4–0	15 min.	8	8
22.6	"	40	8	8
22.6	"	34	8	8
21.5	"	20	8—	8
21.5	"	50	8—	8
25.	"	35	7 n. p.	8
25.	"	30	8	8
23.	"	47	8—	8
22 5	"	28	8+	8
21.	"	32	8—	8

percentage than the check plant indicated. The result was either as in this case a lack of plasmolysis or only slight indications of it.

The three measurements indicating a turgor force of 20 are introduced to illustrate the variations that appear without any

assignable reason. From other experiments it is not at all possible to conclude that temperature is the cause of the rise.

In Table II. will be found some of the results obtained by germinating spores of *Mucor* in a nourishing solution containing 4% KNO_3 and transfering to a simple nourishing solution.

Here again there is a complete agreement between the turgor forces of the plants grown under the different conditions; the slight variations indicated by the — or the + are of little importance as they are found to be equally distributed throughout my experiments. The turgor force was not always as constant as indicated in column 5, some tests showing a force of 7 and a few of 9. In the majority of cases it was very constant.

In Table III. are given a few of the results of experiments on *Botrytis*.

III.

1	2	3	4	5
21.	0-4	.41 min.	22	22
22.2	"	.60	22 —	22
22.6	"	1.12	22 n. p.	22
21.	"	1.10	22	22
21.8	"	.50	23	23
23.4	"	1.35	22 n. p.	23
24.	"	1.53	21	21

IV.

1	2	3	4	5
22.	4-0	50 min.	12 n. p.	13
22.8	"	51	12	12
21.6	"	55	12 +	12
23.4	"	42	12	12
22.6	"	62	12 —	12
22.6	"	38	12	12
24.	"	46	12	12

The generally longer period of recovery noted in Table IV. is not due apparently to the considerably higher turgor force developed in the plants, since the difference of turgor in the 4% and null solutions is practically the same in both *Botrytis* and *Mucor*, *i. e.*, 10. On the other hand the periods of recovery found in Table III. are somewhat shorter than in Table I.

The tests upon *Penicillium* were more unsatisfactory than any of the others owing to the fact that the turgor varied considerably

on different occasions. It might naturally be supposed that this was due to some faulty application of the plasmolyzing solutions. More tests, however, were made upon *Penicillium* than upon any of the others in the hope of securing uniform measurements. But the fact remained that there would occur variations of one to three per cent. But this fluctuation does not affect the results of the work because of the practice of comparing every measurement obtained in an experiment with the turgor force of a test plant.

V.

1	2	3	4	5
21.	0–4	63 min.	16—	16
21.4	"	41	16	16
21.8	"	76	15	15
21.8	"	70	13	13
21.6	"	46	16	16
22.	"	47	16—	16
21.4	"	88	16+	16

VI.

1	2	3	4	5
22.6	4–0	21	10—	10
22.8	"	25	10	10
22.8	"	45	10	10
22.	"	38	8+	8
21.4	"	22	9+	9
21.6	"	50	9	9
21.	"	42	9	9

It is very noticeable that the turgor force has a marked influence in regulating the period of recovery. While in Table III. it is more usually over one hour and averages somewhat higher than the table indicates, in Table V. the recovery is decidedly shorter. The same ratio exists in Tables IV. and VI. In the case of *Botrytis* there was produced by the changes of the substratum a difference of 10 in the turgor force while in *Penicillium* this only amounted to about 6. The results obtained in the experiments with *Mucor* are not so easily explained, for while the period of recovery is shorter than in *Penicillium*, when changing from 4 to 0, the reverse change results in a rather longer period of retardation approximating that of *Botrytis*. This latter relation would be be expected since the difference in turgor produced by the two

substrata are about equal, *i. e.*, 10. It is quite possible that the structure of the two plants has much to do with the variation, the one being essentially weak in this particular and the other septate.

I was interested to substitute NaCl for KNO_3 for the purpose of determining whether the replacement of a salt that is of so vital importance to the plant with one of slight value would produce any pronounced results. The action of this salt was most striking and it was found impossible to use only comparatively weak solutions. *Mucor* would not tolerate as well a 2 per cent. solution as the corresponding value of KNO_3, and this often produced bursting in *Botrytis*. *Penicillium* was more resistant and would usually withstand a change from 4 to 0. The results may be summarized as follows:

Mucor in a temperature averaging 24.5 recovered very slowly in changing from a nutrient solution to 2% NaCl solution. The period ranged from 3 hours and 40 minutes to 5 hours and 46 minutes and the turgor was found to be 21–22 in the recovering and test plant. In transferring from 2 to 0 recovery was effected in 19 to 43 minutes, turgor force 9. This higher turgor force (9) was probably due to the temperature and this is to be noticed generally in all work done in the summer. *Penicillium* recovered, temperature 25, from a change of 0 to 2 in 1.24 to 2.36 hours, turgor in all comparative tests alike and ranging from 19 to 20. Transferring from 2 to 0, recovering in 36 to 56 minutes, turgor ranging from 11 to 12. Changed from 0 to 4 solution, recovery 1.55 to 2.50 hours, turgor 29–30; transferred from a 4 to 0, recovery in 31 to 70 minutes with turgor force as stated above. *Botrytis*, transferred from 0 to 2% solution, recovered in 1.40 to 3.10 hours, turgor 23–24. Changing from 2 to 0, recovering in 30 to 80 minutes, turgor 13. These tests show the same results and general relations as those found in Tables I and II. The excessive turgor pressure is manifestly due to the injurious and retarding influence of the NaCl upon the rate of growth.

A summary of the results obtained with the higher concentrations of the KNO_3 nourishing solutions is given below. *Penicillium* was found to have the greatest power of adaptation and would sometimes withstand a transfer from 19 to 0 solution without seri-

ously bursting all of the hyphae. In transferring *Penicillium* from 0 to 9 recovery followed in 2 to 5.30 hours, turgor 28. Changing from 9 to 0, recovery in 50 minutes to 1.50 hours, turgor 11; changed from 0 to 14, recovery 2.40 to 7 hours, turgor 36; changed from 14 to 0 recovery, 55 to 1.41, turgor 11; changed from 0 to 19, recovery 5.40 to 12.18 hours, turgor 43. *Botrytis* 0 to 9, recovery in 1.56 to 6.10 hours, turgor 34, 9 to 0, recovery 48 to 2.21, turgor 13, 0 to 14, recovery in 3.10 to 7.43, turgor 39. Less importance is attached to these experiments owing to the frequent bursting of the hyphae. However, they show that the same relations exist between the turgor of the recovering plant and the test plant as appeared in the preceding work.

The result of the work was unexpected and seems to indicate that a much closer relation exists between turgor and growth in these simple plants at least than has been supposed. I had anticipated finding several percentages of difference between the turgor force of the plant just recovering from a change of substratum and that of a plant germinated and grown in this substratum. It appears from these experiments that there is a necessity of a certain turgor force before growth is possible and that growth cannot occur until a turgor pressure has been reached which is normal to the plant growing in the given solution. That turgor is not alone the cause of growth is apparent from the acceleration of the rate of growth after a change of substratum. In the following statements it will be seen that there is always a short period of slow growth. The figures represent divisions on the micrometer eye piece, the periods of measurement being 5 minutes.

1 5	1.5	1.	2.	.5	.5
1.	1.5	2.	2.5	1.	.5
2.5	2.5	3.5	3.	.5	2.
3.	3.	4.5	3.	1.5	2.5
3.	3.5	6.	3.	3.	3.

Again it is to be noticed that when the turgor pressure was enormously increased by changing from high to low concentrations no growth followed but the quite uniform period of recovery indicates that some agency other than the widely various turgor pressure was at work and it seems quite probable, as has been suggested by Townsend and by True, that the cessation of growth is to

be considered as the response of the irritability of the protoplasm due to shock. In fact, the measurements obtained by Townsend by injuring the hyphae and observing the period of recovery correspond with some of the above measurements. This shock also entered as a factor in the changes from low to higher concentrations, but the periods of recovery constantly grew longer in as much as the accumulation of turgor force is a slow process and requires more time than recovery from shock. In the cases where we are dealing with a reduction of the turgor force a comparative short period, *i. e.*, the recovery from shock, is sufficient to adjust the turgor since this is brought about by purely physical laws. The accumulation of high pressures in the plants retarded in their growth by NaCl and the low turgor of the plants growing rapidly in solutions of slightly lower concentration, a phenomenon that has often been discussed, seem to point to the same conclusion. A certain maximum turgor force is necessary to start growth. If for any reason growth is checked there follows an increase of the pressure tending to continue the normal growth. Under the reverse conditions a rapid growth lowers the pressure which is, however, high enough to play its rôle in growth. Eschenhagen has demonstrated that the turgor pressure of fungi is considerably in excess of the substratum in which they are growing and this is to be looked upon as an adaptive provision permitting changes of substratum. It is possible that there must also be a certain excess of turgor to inaugurate growth and higher than is actually required to sustain it. Naturally a rapid growth expends a portion of this surplus reducing turgor. These variations of pressure are comparable to the work done in overcoming the inertia of an object at rest, a greater force is required to start the motion that is necessary to maintain it. A better comparison is found in a water reservoir with a constant supply and a siphon discharge. A certain maximum volume of water is required to bring the siphon into action, but once in action it will continue the flow of water, though the volume in the reservoir is greatly reduced. Furthermore, by reducing the caliber of the siphon the volume rises, but by increasing it the volume diminishes in both cases in proportion to the area of the siphon.

Turgor then is regulatory in its action. We can neither say

that it controls growth nor, on the other hand, is it controlled by growth, but it must sustain a certain fixed relation and come into harmony with the other existing forces and conditions before growth is possible.

The more important features of the work may be summarized as follows:

1. The hyphae of fungi possess remarkable powers of adaptation but show considerable individuality in this respect.

2. The turgidity varies under uniform conditions.

3. The moment of recovery from a change of concentration can be accurately noted since it is indicated by an apical enlargement preceding the elongation of the hypha.

4. Changes from a low to a higher conception of the substratum resulted in a steadily increasing period of recovery in proportion to the concentration of the substratum.

5. Recovery from a change from a higher to a lower concentration was controlled only to a limited extent by the degree of concentration. But there was also to be observed an individuality peculiar to the genus employed which brought about these changes in shorter or longer periods of time.

6. The turgidity of a plant recovering from a change of concentration is the same as that of a plant germinated and growing in the concentration to which the trial plant has been changed.

7. Turgidity appears to be a regulatory force.

New Species of Fungi

By Charles H. Peck

Amanita calyptrata

Pileus fleshy, thick, convex or nearly plane, centrally covered by a large irregular persistent grayish white fragment of the volva, glabrous elsewhere, striate on the margin, greenish yellow or yellowish brown tinged with green, the margin often a little paler or more yellow than the rest: lamellae close, nearly free but reaching the stem and forming slight decurrent lines or striations on it, yellowish white tinged with green: stem stout, rather long, equal or slightly tapering upward, surrounded at the base by the remains of the ruptured volva, white or yellowish white with a faint greenish tint: spores broadly elliptic, 10 μ long, 6 μ broad, usually containing a single large nucleus.

Pileus 10–20 cm. broad: stem 10–15 cm. long, 12–20 mm. thick.

Rich ground in fir woods or their borders. Autumn. Oregon. Dr. H. Lane.

This is a large and interesting species, well marked and easily recognized by its large size, by the greenish tint that pervades the pileus, lamellae, annulus, and stem and especially by the large persistent patch of grayish white felty material that covers the center of the pileus and sometimes extends nearly to the margin. This is in fact the upper part of the ruptured volva that is carried up by the growing plant and is very suggestive of the specific name. In the young state the plant is entirely enveloped in the volva which then is similar to a goose egg in size and shape, and its walls are one-fourth to one-half an inch thick. So thick and firm are they that the young plant appears sometimes to be unable to break through and it decays in its infancy.

Dr. Lane says that, having found that the Italians made use of this mushroom for food, he began eating it and introducing it to his friends, and he learned by personal trial that it is a thoroughly good and wholesome mushroom, which, when broiled with bacon, fried, baked or stewed, may be eaten with perfect safety and that it is a nutritious food.

Amanita crenulata

Pileus thin, broadly ovate, becoming convex or nearly plane and somewhat striate on the margin, adorned with a few thin whitish floccose warts or with whitish flocculent patches, whitish or grayish, sometimes tinged with yellow: lamellae close, reaching the stem, and sometimes forming decurrent lines upon it, floccose crenulate on the edge, the short ones truncate at the inner extremity, white: stem equal, bulbous, floccose mealy above, stuffed or hollow, white, the annulus slight, evanescent: spores broadly elliptic or subglobose, 7.5–10 μ long, nearly as broad, usually containing a single large nucleus.

Pileus 2.5–5 cm. broad: stem 2.5–5 cm. long, 6–8 mm. thick.

Low ground, under trees. Eastern Massachusetts. September. Mrs. E. Blackford and George E. Morris.

The volva in this species must be very slight, as its remains quickly disappear from the bulb of the stem. The remains carried up by the pileus form slight warts or thin whitish areolate patches. The annulus is present in very young plants, but is often wanting in mature ones, in which state the plant might be mistaken for a species of *Amanitopsis*. Its true affinity is with the tribe to which *Amanita rubescens* belongs. As in that species, the bulb soon becomes naked and exhibits no remains of the volva. It is similar to *Amanitopsis farinosa* also in this respect, but quite unlike it in color, in the adornments of the pileus and in the character of its margin, which is even in the young plant and but slightly striate in the mature state. Its dimensions are said sometimes to exceed those here given, and it is reported to have been eaten without harm and to be of an excellent flavor. I have had no opportunity to try it.

Lepiota rugulosa

Pileus thin, submembranaceous, broadly convex or nearly plane, umbonate, rugulose, widely striate on the margin, whitish: lamellae thin, narrow, close, free, whitish: stem short, equal, slightly silky, whitish, the annulus thin, persistent, white: spores elliptic, 7.5 μ long, 4 μ broad.

Pileus 12–20 mm. broad: stem about 2.5 cm. long, 2 mm. thick.

Moist grassy places under trees. Washington, D. C., July. Mrs. E. M. Williams. Perhaps in the fresh state the pileus is not as distinctly rugulose as when dry.

Agaricus brunnescens

Pileus thick, firm, hemispherical, becoming convex or nearly plane, fibrillose, sometimes slightly squamose, bay brown or brownish, the margin extending beyond the lamellae and appendiculate by the remains of the veil, flesh whitish or grayish white, unchangeable, taste agreeable: lamellae close, rounded behind, free but reaching the stem, at first whitish, then reddish pink, finally brown: stem short, silky, stuffed or hollow, whitish, the annulus thick, of a soft felty texture, persistent, whitish, often striated on the upper surface by impressions of the edges of the lamellae: spores broadly elliptic or subglobose, 6–8 μ long, 4–6 μ broad.

Pileus 5–10 cm. broad: stem 2.5–4 cm. long, 8–16 mm. thick.

Dump ground on deposits of manure and street scrapings. East Cambridge, Mass. September and October. Miss Helen M. Noyes.

The species differs from the common mushroom, *A. campester*, in its brown color, in its thicker and more persistent collar, its hollow stem and more rosy tint of the immature lamellae. The cavity of the stem is small. From *A. maritimus*, to which it has some points of resemblance, it may be separated by its darker color, its thicker and more persistent collar and by its flesh not assuming reddish hues where wounded.

Mr. G. B. Fessenden informs me that he found this mushroom seven years ago growing in soil made of the sweepings of cattle cars, but that he had not seen it since until this season. The plants are gregarious and grow in very rich loose and dryish soil composed of manure and sweepings of streets and cattle cars. They continue to appear for several weeks in succession or until cold weather stops their growth. They frequemtly develop fully beneath the surface of the ground. *A. maritimus* also has this same peculiarity. It is an edible species and is eagerly sought by Italians who are after them every day by 4 o'clock in the morning.

Stropharia irregularis

Pileus thin, fragile, subcampanulate, irregular, umbonate, glabrous, often rimose about the umbo and split on the thin wavy or irregular margin, whitish, grayish or yellowish, often white on the margin: lamellae close, dingy pink when young, becoming brown with age: stem slender, fragile, slightly floccose, hollow, often cracking transversely, shining, white, the slight annulus soon

breaking into fragments and disappearing: spores elliptic, 6–7.5 μ long, 4–5 μ broad.

Pileus 2.5–5 cm. broad: stem 5–14 cm. long, 4–6 mm. broad.

Cespitose. Mountain pastures. Linden, Va. August. Mrs. E. M. Williams.

Boletus caespitosus

Pileus broadly convex or nearly plane, sometimes slightly concave by the elevation of the margin, even, brown or blackish brown, the margin often a little paler or reddish brown, flesh slightly tinged with red: tubes adnate or slightly decurrent, yellow, their mouths rather large, angular, concolorous: stem short, even, solid, glabrous, tapering upward, brown or reddish brown: spores oblong elliptic, 10 μ long, 5 μ broad.

Pileus 1–2.5 cm. broad: stem 2–2.5 cm. long, 4–6 mm. thick.

Cespitose. Virginia. August. R. S. Phifer.

A small species growing in tufts and referrable to the tribe *Subtomentosi*. The tubes retain their bright yellow color in the dried specimens.

Boletus subsanguineus

Pileus convex or slightly depressed in the center, glabrous, viscid, bright red or scarlet, flesh thick, firm but flexible, white, slowly changing to a pale brownish lilac on exposure to the air, taste slightly bitter: tubes very short, 2–4 mm. long, adnate but often separating from the stem with the expansion of the pileus, reddish, the mouths minute, stuffed at first, pinkish, then brownish yellow changing to a light brown where wounded: stem short, thick, uneven, often tapering downward, streaked with red, pale yellow at the top, white at the base, marked at the top by the decurrent walls of the tubes.

Pileus 2.5–10 cm. broad: stem 2.5–5 cm. long, 2–4 cm. thick.

Solitary, gregarious or cespitose. Under beech trees. West Philadelphia, Pa. August. C. McIlvaine.

This is a very showy species, easily recognized by its bright red viscid pileus and its short thick and uneven or somewhat lacunose stem. It is closely related to the European *B. sanguineus* With from which it is separated by its minute tubes, its uneven stem and the brownish hues assumed where wounded.

The spore characters of this and the four succeeding species are unknown, but the other characters are quite distinctive and ap-

parently sufficient for the recognition of the species. The descriptions have been derived from colored figures and other data furnished by Mr. McIlvaine who says all are edible.

Boletus eccentricus

Pileus thick, firm, convex, irregular, glabrous, more or less lobed or wavy on the involute margin, gray or yellowish gray, flesh white, close grained, elastic, unchangeable, taste and odor farinaceous: tubes convex, depressed around the stem, not reaching the margin of the pileus, somewhat uneven or pitted on the surface, yellowish brown, the mouths subangular, at first concolorous, becoming reddish or reddish purple: stem eccentric, tapering downward, solid, uneven with short irregular shallow grooves or obscure reticulations, tinged with red at the top, grayish below, tinged with red or purple within at the base.

Pileus 5–10 cm. broad: stem 4–5 cm. long, 3–4 cm. thick at the top.

Sandy soil in grassy places in woods. Mt. Gretna, Pa. August and September.

The species is well marked by its eccentric stem, thick irregular pileus and the reddish or reddish purple mouths of the mature tubes. Mr. McIlvaine remarks that when it is cooked it is delicate and savory.

Boletus badiceps

Pileus firm, convex or somewhat centrally depressed when mature, dry, velvety, obliquely truncate on the margin, bay red or dark maroon color, flesh white, unchangeable, taste and odor mild, sweet, suggestive of molasses: tubes plane, adnate, white or whitish, becoming dingy with age, the mouths minute: stem equal or slightly swollen in the middle, radicating, glabrous, solid, brownish.

Pileus 4–8 cm. broad: stem 4–5 cm. long, 1.5–3 cm. thick.

Oak woods. West Philadelphia, Pa. August and September.

The truncate or beveled margin of the pileus is a striking feature in this species. It is about 4 mm. broad and as even as if cut with a knife. Sometimes the surface of the stem ruptures transversely just below the top, the liberated shreds above curling upward against the tubes and those below curving outward and downward. In mature plants brownish spots appear in the flesh of the pileus. "When cooked it is of high flavor and tender as kidney," C. McIlvaine.

Boletus crassipes

Pileus convex or centrally depressed, firm, dry, velvety, brown tinged with yellow, the wavy or lobed involute margin extending beyond the tubes, flesh lemon yellow, unchangeable, taste sweet, odor like that of yeast: tubes rather short, depressed around the stem, almost free, yellowish mottled with brown, the mouths minute, stuffed when young: stem stout, thick, sometimes swollen in the middle and sometimes bulbous, beautifully reticulated but the reticulations sometimes disappearing with age, orange yellow tinged with brown, flesh of a brighter yellow than that of the pileus.

Pileus 5–10 cm. broad: stem 6–8 cm. long, 2.5–3.5 cm. thick.

Oak woods. Mt. Gretna, Pa. August and September.

The thick, beautifully reticulated stem, the deep velvety brown color of the pileus and the yellow color of the flesh serve to distinguish this species.

Boletus fulvus

Pileus thick, convex or subcampanulate, dry, glabrous, rimose areolate, tawny yellow, the extreme margin dark brown, flesh spongy, tough, white, slowly assuming a reddish tint on exposure to the air: tubes rather long, ventricose, depressed around the stem and free or nearly so, greenish yellow, the mouths small, tawny yellow: stem rather long, often narrowed and striate at the top, dotted with brownish orange granules or points, radicating, tough, stuffed with greenish yellow fibers, colored like the pileus.

Pileus 5–7.5 cm. broad: stem 10–12.5 cm. long, 8–16 mm. thick.

Cespitose on decaying stumps. West Philadelphia, Pa. August. Mr. McIlvaine says that there were between 20 and 30 specimens on and about an old stump and that they were as attractive to the eye as a cluster of *Clitocybe illudens*.

Polyporus albiceps

Pileus tough, plane or slightly depressed in the center, even, glabrous, dry, opake, white without and within: pores short about 1 mm. long, minute, subrotund, decurrent, white, the thin dissepiments dentate on the edge: stem central or nearly so, subequal, glabrous, solid, pallid.

Pileus 2.5–5 cm. broad: stem 2.5–4 cm. long., 6–8 mm. thick.

Decaying wood buried in the ground under walnut trees. Sea beach, New Hampshire. Mrs. A. M. Hadley.

Stereum pulverulentum

Resupinate, hard, adnate, tuberculose, crowded, appearing as if confluent in a continuous stratum with the tubercles separated by narrow cracks, the surface pulverulent, pale clay color inclining to wood-brown.

Bark of paper birch, *Betula papyrifera*. Orono, Maine. October. F. L. Harvey.

The species is related to *Stereum frustulosum*, but the tubercles are more crowded, smaller and thinner than in that species and have no blackish margin. The pulverulence is more conspicuous on the larger and thicker ones.

Guepinia biformis

Pileus stipitate, at first erect and cupulate, then curved to one side, often split to the stem on one side and lobed on the margin, tough, gelatinous and tremelloid when moist, tapering downward into the stem, minutely granulose tomentose or subvelvety and grayish or dingy buff externally: the hymenium glabrous, even or with a few folds or ridges radiating from the base, reddish-brown: stems terete or compressed, tough or coriaceous, velvety tomentose, grayish or dingy buff, often seriately confluent at the base.

Pileus 6–12 mm. broad: stem 4–10 mm. long, 2–4 mm. thick.

Decaying wood of deciduous trees. Ames, Iowa. September. Miss Alice Hess.

The species is apparently related to *G. cohaerens* Mig., *G. cochleata* B. & Br. and *G. palmiceps* Berk., from all of which it differs in color. The hymenium when moist resembles raisins in color and when turned to one side it is strongly suggestive of the apothecia of some species of *Peltigera*. The tomentum of the stem is similar to that of the exterior surface of the pileus.

Hypomyces volemi

Subiculum very thin, whitish or isabelline: perithecia minute, brown, nestling in the subiculum: asci very slender, 100–125 μ long, sporiferous part, 4 μ broad: spores oblong fusiform, 12–15 μ long, 4 μ broad, commonly binucleate.

Parasitic on the hymenium of *Lactarius volemus*. Pennsylvania. Charles McIlvaine.

The hymenium of the host plant is changed in appearance by the parasite, but the stem and upper surface of the pileus remain unchanged.

Cordyceps nigriceps

Club subovate, obtuse, minutely papillose from the slightly prominent perithecia, greenish black when fresh and moist, black when dry, about 12 mm. long and 10 mm. broad, the margin free and extending below the attachment to the stem: stem equal, solid, pale cadmium yellow toward the base, suffused with bluish green above, pale yellow at the top, white within, 7–8 cm. long, 5–6 mm. thick: asci 280–350 μ long, 12 broad: spores 8, filiform, hyaline, separating into cylindric segments, each 20–40 μ long, 4 μ broad, generally containing 3–6 minute nuclei.

Among fallen pine leaves. Saco, Maine. November. Charles L. Fox.

The substance on which the specimens grew was not ascertained, but probably it was some subterranean fungus. The species is remarkable for the pileate character of the club by which it may be distinguished from its allies. It resembles *Cordyceps capitata* but may be readily distinguished from it by the free margin of the club and the more narrow spore segments. In drying the green hues disappear.

Macrophoma curvispora

Perithecia minute, numerous, erumpent, surrounded and partly covered by the remains of the ruptured epidermis, black: spores oblong, curved, colorless, 15–17 μ long, 4 μ broad, supported on sporophores as long as or a little longer than the spores.

Bark of apple trees. British Columbia. Collected by R. M. Palmer. Communicated by William Paddock.

The fungus seems to cause the bark of the branches to loosen and crack.

Fistulina hepatica monstrosa n. var.

Subglobose, supported on a short stem or stem-like base, the external surface entirely covered with tubules 2–4 mm. long.

Pennsylvania. C. McIlvaine. In color and texture resembling the common form, but Mr. McIlvaine informs me that there is nothing in the position or place of growth of the specimens to account for their peculiar character. They are 3–4 inches in diameter.

An Enumeration of the Plants collected by Dr. H. H. Rusby in South America, 1885–1886, XXVIII

By H. H. Rusby

(Continued from Bull. Torr. Club, **26**: 200 10 Ap. 1899.)

Cestrum sparsiflorum Britton, sp. nov.

Younger portions of the stem sparsely puberulent; branches elongated, straight and rigid: petioles 5 mm. long, narrowly margined: blades 6–12 cm. long, 2–4 cm. broad, oblong, acuminate at both ends, the point slender and very acute, entire, dark-green, thin but rigid, the midrib channeled above, underneath terete and prominent, like the 10–12 pairs of very slender, strongly upwardly arched secondaries, which connect near the margin: peduncles solitary from the axils, together with the rachis about 2 or 3 cm. long, slightly recurved, angled, several-flowered, the flowers more or less secund, sessile upon small nodular bases: calyx 5 mm. long, 2 or 3 mm. broad, campanulate, lobed one-fourth of the way, the lobes triangular-acuminate and acute: corolla-tube many-nerved, 2 cm. long, at the base 1 mm., at the summit 2.5 mm. broad, the base loosely enclosed in the calyx, the lobes 6 mm. long, triangular-ovate: fruit not seen.

Yungas, 6000 ft., 1885 (no. 816).

Sessea dependens R. & P. Fl. Per. **2**: 9. *pl. 116.* Unduavi, 10000 ft., Oct., 1885 (no. 2625). The same as Mandon's no. 450.

Fabiana imbricata R. & P. Fl. Per. **2**: 12. *pl. 122.* Near Valparaiso, Chili, June, 1885 (no. 825). Local name "Pichi."

Nicotiana undulata R. & P. Fl. Per. **2**: 16. Mapiri, 5000 ft. April, 1886 (no. 822). The same as Bang's no. 1858.

Nicotiana tomentosa R. & P. Fl. Per. **2**: 16. Yungas, 6000 ft., 1885 (no. 2435). Grows 12 to 15 feet high, the leaves very large and with a strong odor of tobacco.

Nicotiana pandurata Dunal; DC. Prod. 13: *pl. 569.* Beni River, July, 1886 (no. 821).

Nicotiana glauca Grah. Bot. Mag. *pl. 2837.* Vic. La Paz, 10000 ft., April, 1885 (no. 813). Grows on banks of streams; the leaves used as a narcotic.

Nicotiana Rusbyi Britton, sp. nov.

Glandular-hairy, the leaves shortly and finely soft-tomentose; stems stoutish, flexuous, erect: petioles (largest leaves not present) 2–4 cm. long, stout, margined: blades .8–2.5 dm. long, .3–1.2 dm. broad, ovate, the base abruptly contracted into the petiole, short-pointed and acute at the apex, entire, thick and rigid, the venation slender, not prominent except the midrib underneath: inflorescence widely and loosely paniculate (in the specimens 3 dm. long and broad), the branchlets subulate-bracted: pedicels short, becoming about 1 cm. long and erect in fruit: calyx in flower 5 mm., in fruit 1 cm. long, campanulate, lobed about one third of the way, the lobes triangular, acute, the sinuses about the same: corolla 1.5–2 cm. long, about 5–7 mm. broad, lightly curved and ventricose, apparently pale-yellow, the lobes about 5 mm. long, triangular-ovate: capsule elongated-globular, about 7 mm. long, or, after opening, the valves nearly 1 cm. long.

Yungas, 4000 ft., 1885 (no. 2434). The same as Bang's no. 1182.

Nierembergia pulchella Gill. ex Miers; Hook. Lond. Journ. Bot. **5**: 173. 1846. Vic. La Paz, 10000 ft., April, 1895 (no. 1982). The same as Mandon's, no. 1476.

Schizanthus pinnatus R. & P. Fl. Per. **1**: 13 f. 17. Near Valparaiso, Chili, June, 1885 (no. 1023).

Brunfelsia latifolia (Pohl.) Benth. in DC. Prod. **10**: 199 (*Franciscea latifolia* Pohl. Pl. Bras. Ic. 3. *pl. 2*) Mapiri, 5000 ft., April, 1886 (no. 621) and Beni River, July, 1886 (no. 2122).

Brunfelsia hydrangeaeformis (Pohl.) Benth.; DC. Prod. **10**: 108 (*Franciscea hydrangeaeformis* Pohl Pl. Bras. Ic. **1**: 7. *pl.* 7.) Yungas, 4000 ft., 1885 (no. 1030), Mapiri, 2500 ft., May, 1876 (no. 2611) and Beni River, July, 1886 (no. 862).

SCROPHULARIACEAE.

Fagelia chelidonioides (H.B.K.) Kuntze Rev. Gen. Pl. **2**: 459. Unduavi, 8000 ft., Oct., 1885 (no. 1056).

Fagelia integrifolia (Murray) Kuntze Rev. Gen. Pl. **2**: 460 (*Calceolaria integrifolia*) Murr Syst. ed. 13, 64. Near Valparaiso Chili, June, 1885 (no. 1051).

Fagelia polifolia (Hook.) Kuntze Rev. Gen. Pl. **2**: 460 (*Calceolaria polifolia*) Hook. Bot. Mag. *pl. 2897*. Near Valparaiso, Chili, June, 1885 (no. 1054).

Fagelia teucrioides (Griseb.) (*Calceolaria teucrioides* Griseb. Goett. Abh. **19**: 212. 1874?). Vic. La Paz, 10000 ft., Apr., 1885 (no. 1058). The flowers are distinctly larger, and it will very likely prove to be an undescribed species.

Fagelia virgata (R. & P.) Kuntze Rev. Gen. Pl. 460 (*Calceolaria virgata* R. & P. Fl. Per. **1**: 20 *pl. 31*). Sorata, 8000 ft., Feb., 1886 (no. 1060).

Fagelia canescens (Willd.) Kuntze Rev. Gen. Pl. **2**: 459 (*Calceolaria canescens* Willd. ex Roem. & Schult. Syst. Mant. **1**: 165). Vic. La Paz, 10000 ft., Apr., 1885 (no. 1053). This species, with several others, forms a dense mass of low shrubbery on gravelly banks, resembling a growth of *Vaccinium*.

Fagelia scabra (R. & P.) Kuntze Rev. Gen. Pl. **2**: 460 (*Calceolaria scabra* R. & P. Fl. Chil. **1**: 19. *pl. 59*). Yungas, 6000 ft., 1885 (no. 1057).

Fagelia Boliviana Britton, sp. nov.

Puberulent throughout: branchlets elongated, erect or ascending, coarsely angled: petioles .5–1 cm. long, broad, weak: blades 4–6 cm. long, 2–3 cm. broad, ovate, rounded at the base, acuminate and acute at the apex, rather coarsely crenate, the yellowish midrib and 7–9 pairs of strongly ascending secondaries rather prominent underneath: cymes 5–8 cm. broad, loosely about 10-flowered: the peduncles 2–5 cm. long: pedicels 1–1.5 cm. long, stoutish, ascending: calyx about 7 mm. long, foliaceous, the ovate obtuse lobes not very unequal: corolla (as pressed) about 2 cm. long and broad, bright yellow: style 6 mm. long, stoutish, slightly tapering: the stigma capitate, small.

Yungas, 6000 ft., 1885 (no. 1052).

Alonsoa acutifolia R. & P. Syst. Veg. 153. Sorata, 8000 ft., Feb., 1886 (no. 1084).

Alonsoa incisaefolia R. & P. Syst. Veg. 154. Sorata, 8000 ft., Feb., 1886 (no. 1086). The same as Mandon's 464.

Galvesia Limensis Dombey ex. Chav. Monog. Antirrh. 180, Payta, Peru, Feb. 6, 1883 (no. 2504).

Leucocarpus alatus G. Don.; Sweet Brit. Fl. Gard. **5**: *pl. 124*. Yungas, 6000 ft., 1885 (no. 2423).

Mimulus glabratus H.B.K. Nov. Gen. et Sp. **2**: 370. Sorata, 10000 ft., Feb., 1886 (no. 1096).

Stemodia Chilensis Benth. Bot. Reg. *pl. 1470*. Near Valparaiso, Chile, June, 1885 (no. 1072).

Monniera procumbens (Mill.) Kuntze, Rev. Gen. Pl. **2**: 463 (*Erinus procumbens* Mill. Gard. Dict. ed. 8, n. 6. *Herpestis chamaedryoides* H.B.K. Nov. Gen. et Sp. **2**: 369). Falls of Madeira, Brazil, Oct., 1886 (no. 1094).

Forenia parviflora Buch.-Ham. ex Wall. Cat. no. 3958. Falls of Madeira, Brazil, Oct., 1886 (no. 1388).

Vandellia diffusa L. Mant. 89. Guanai, 2000 ft., May, 1886 (no. 2566), and Falls of Madeira, Brazil, Oct., 1886 (no. 1775). The drying plant has the odor of tobacco.

Ilysanthes gratioloides (L.) Benth.; DC. Prod. **10**: 419 (*Capraria gratioloides* L. Syst. ed. X, 1117). Guanai, 2000 ft., May, 1886 (no. 2566).

Sibthorpia nectarifera Wedd. Chlor. And. **2**: 111. Sorata, 13000 ft. Feb., 1886 (no. 2477). The same as Mandon's 471.

Sibthorpia pinchinchensis H.B.K. Nov. Gen. et Sp. **2**: 390. *pl. 176* (?) Unduavi, 8000 ft., Oct., 1885 (no. 1245). The same as Mandon's 470.

Scoparia pinnatifida Cham., in Linnaea **8**: 22. 1833. Falls of Madeira, Brazil, Oct., 1886 (no. 2603).

Scoparia dulcis L. Sp. Pl. 116. Mapiri, 5000 ft., Apr., 1886 (no 1817), and falls of Madeira, Brazil, Oct., 1886 (no. 1374).

Ourisia chamaedrifolia Benth. in DC. Prod. **10**: 493. Sorata, Bolivia, 10000 ft., Feb., 1886 (no. 1104). Also collected near Unduavi.

Veronica peregrina L. Sp. Pl. 14. Sorata, 10000 ft., Feb., 1886 (no. 1854).

Gerardia rigida Gill. ex Benth. in Hook. Comp. Bot. Mag. **1**: 206. 1835 (?). The long recurved calyx-teeth are as in *G. genistillifolia*, but the stem is quite different. Vic. La Paz, 10000 ft., Apr., 1885 (no. 1079). The same as Bang's no. 2530 and no. 2854.

Gerardia lanceolata (R. & P.) Benth. in Hook. Comp. Bot. Mag. **1**: 207. 1835 (*Virgularia lanceolata* R. & P. Syst. Veg. 161). Unduavi, 8000 ft., Oct., 1885 (no. 1078) the same as Mandon's no. 479. No. 1077, from Sorata, 10000 ft., Feb., 1886, the same as Pearce's collection at Muña, 8000–9000 ft.

Gerardia brevifolia sp. nov.

Foliage lightly scabrous, the corolla pubescent: stems stout, erect and erect-branched, terete, the branchlets quadrangular,

densely leafy: leaves sessile, .75–2 ½cm. long, 3–27 mm. broad, lance-oblong, obtuse at the base, the apex blunt but apiculate, entire, very thick, the midrib very stout and prominent underneath, the broader 3-nerved: pedicels 5–8 mm. long, stout: calyx thick, about 1.25 cm. long, lobed about half way, the tube campanulate, the lobes triangular, acute, the sinuses rather broader, obtuse: corolla-tube 2.5 cm. long, 1 cm. broad, infundibular-campanulate, the lobes 7 mm. long, the 3 lower 6 or 7 mm. broad, the margin rounded, obscurely sinuate, the 2 upper united: stamens not reaching to the base of the corolla-lobes, the filaments adnate to the lower fourth of the corolla, the anthers 4 mm. long: style about equaling the stamens: capsule about 1 cm. long, broadly oval or subglobose.

Yungas, 6000 ft., 1885 (no. 1080). This is the same as Pearce's from Unduavi, 10000 ft., July, 1866. No. 1082, from Sorata, 8000 ft., Feb., 1886, the same as Mathews' no. 3137, is probably of this species also.

Castilleia communis Benth.; DC. Prod. **10**: 529. Sorata, 10000 ft., Feb., 1886 (no. 1097). The same as Mandon's no. 475.

Castilleia pumila (Benth.) Wedd. Chlor. And. **2**: 119 (*Castilleia nubigena pumila* Benth.; DC. Prod. 10: 534). Sorata, 13000 ft., Feb., 1896 (no. 1088).

Castilleia fissifolia L. F. Suppl. 293. Sorata, 10000 ft., Feb., 1886 (no. 1087).

Bartsia laxiflora Benth.; DC. Prod. **10**: 547. Sorata, 10000 ft., Feb., 1886 (no. 1089). The same as Bang's 691. All these *Bartsias* grow on open, grassy hillsides, especially in wet places.

Bartsia patens Benth.; DC. Prod. **10**: 546. Unduavi, 8000 ft., Oct., 1885 (no. 1090). The same as Bang's 2028.

Bartsia inaequalis Benth.; DC. Prod. **10**: 545. Sorata, 10000 ft., Feb., 1886 (no. 1091). The same as Mandon's 480 and Bang's 668.

Bartsia breviflora Benth.; DC. Prod. **10**: 545. Sorata, 13000 ft., Feb., 1886. The same collected by Pearce at Peluchuco.

Bartsia hispida Benth.; DC. Prod. **10**: 547 (?) Sorata, 10000 ft., Feb., 1886 (no. 1083). This bears some resemblance to *B. subincisa*. No. 1349, from Sorata, 10000 ft., may be the same, but my specimen is fragmentary.

LENTIBULACEAE

Utricularia alpina Jacq., Enum. Pl. Carib. 11. Mapiri, 8000 ft., May, 1886 (no. 2765). The same collected by Bang.

Utricularia pusilla Vahl. Enum. **1**: 202. Yungas, 4000 ft., 1885 (no. 1357).

Pinguicula antarctica Vahl. Enum. **1**: 192 (?) Unduavi, 8000 ft., Oct., 1885 (no. 1356). Collected at the same place by Pearce. Grows on wet mossy banks and rocks.

GESNERIACEAE

Achimenes Rusbyi Britton, Mem. Torr. Club, **6**: 95. Yungas, 4000 ft., 1885 (no. 1102).

Achimenes gracilis Britton, sp. nov.

Sparsely strigose; stems 3–5 dm. long, simple, erect or ascending, slender and weak, coarsely angled and sulcate, from a finely many-branched root: leaves opposite, those of the pair somewhat unequal; petioles .4–1 cm. long, weak: blades .6–1 dm. long, 2.5–3.5 cm. broad, oblong, inaequilateral, narrowed or acuminate at the base, rather abruptly short-pointed and acute at the apex, entire, very thin, deep green above with the very slender venation inconspicuous, pale underneath with the midrib and about 6 pairs of very strongly ascending secondaries slightly prominent: pedicels 5–8 cm. long, filiform: calyx-tube turbinate, 4–5 mm. long, the lobes narrowly linear, the longest nearly 1 cm. long: corolla crimson, the tube 2 cm. long, campanulate, somewhat ventricose, the spreading limb nearly 2 cm. broad: stamens equaling the corolla tube or slightly exserted, the filaments very slender.

Yungas, 6000 ft., 1885 (no. 2421). Dr. Britton thinks that Pearce's plant, collected at Los Piños, 6000 ft., Mar., 1864, is of this species.

Seemannia ternifolia Regel. Gartenfl. **4**: 183. *pl. 126.* 1855. Unduavi, 8000 ft., Oct., 1885 (no. 1101). The same as Matthews' no. 1335.

Seemannia sylvatica (H.B.K.) Hanst. Linnaea **29**: 540. 1857–8 (*Gesnera sylvatica* H.B.K. Nov. Gen. et Sp. **2**: 393. Yungas, 4000 ft., 1885 (no. 1100). The same also collected by Bang.

Koellikeria argyrostigma (Hook.) Regel. Fl. 250. 1848. Mapiri, 2500 ft., May, 1886 (no. 2658).

Diastemma purpurascens sp. nov.

Sparsely to very sparsely coarse-pilose throughout: stems 4–7 cm. high, tufted, erect, sub-simple, but appearing as though branched by the widely spreading pedicels: petioles 4–6 mm. long, broad, weak: leaves deep purple, 1.5–4 cm. long, 1–2 cm. broad, ovate, abruptly short-produced at the base, blunt at the apex, coarsely sinuate at the margin, thin, the midrib and about 4 pairs of secondaries very prominent underneath: pedicels 1–2 cm. long, thickened upward, weak: calyx-tube turbinate, in flower 3 mm. long by 2 mm. broad, the lobes about equal, rotund ovate, narrowed at the base, spreading or reflexed, herbaceous, both the tube and the lobes greatly enlarging in fruit: corolla nearly 1 cm. long, the tube campanulate, strongly declined or deflexed at the base, the mouth oblique, 7 or 8 mm. broad.

Unduavi, 8000 ft., Oct., 1885 (no. 2604), and Yungas, 4000 ft., 1885 (no. 1984).

Isoloma Sprucei Britton, Mem. Torr. Club, **6**: 97. Mapiri, 5000 ft., Apr., 1886 (no. 2151). The same as Bang's no. 1541 and Spruce's no. 5841.

Isoloma flexuosa sp. nov.

Ferruginous-tomentose, the upper leaf-surfaces coarsely short-strigose: stems ascending, very weak and flexuous, obtusely angled: petioles 1–3 cm. long, weak, broad: blades 4–8 cm. long, 2–5 cm. broad, ovate, rounded at the base, acute at the apex, crenate, thin, pale, the venation coarse, strongly prominent underneath, the secondaries about 10 pairs, strongly incurved, the tertiaries meeting about midway between them: pedicel 2 or 3 cm. long, weak, shaggy: calyx-tube 5 mm. broad, sub-hemispherical, the lobes nearly 1 cm. long, foliaceous, ovate, with contracted base, acute: corolla red, strongly declined, very oblique at the base, less so at the mouth, 1.75 cm. long, 1 cm. broad, as pressed, campanulate, with highly contracted mouth, the short lobes unequal, erect-spreading: anthers all coherent, the quadrilateral mass about 3.5 mm., square: style nearly 1.5 cm. long, thickish, pilose, the stigma slightly dilated, blunt: disk nearly as long as the ovary, of five separate, thick, fleshy glands, two of them larger and 2-lobed.

Yungas, 6000 ft., 1885 (no. 2424).

Isoloma (?) urticifolia sp. nov.

Coarsely pilose, the older portions sparsely, the younger densely, or somewhat tomentose: stems thick, but weak, decumbent or ascending, pale, coarsely angled: petioles 3–5 cm. long, broad

and weak, much dilated at the insertion: blades .5–1 dm. long, 2.5–5 cm. broad, ovate, mostly inaequilateral, the base rounded but abruptly slightly produced into the petiole, acute and short-pointed at the apex, rather coarsely serrate, very thin, pale, the midrib and 9 or 10 pairs of very slender secondaries lightly prominent underneath: cymes mostly 3–5-flowered, the filiform pedicels 2 or 3 cm. long: calyx 5 mm. long, parted almost to the base, the lobes ovate, obtuse, foliaceous, widely spreading: corolla 1.5 cm. long, .75 cm. broad, as pressed, red, cylindraceous, lightly dilated about the middle, the base very oblique, the lobes about 2 mm. long, unequal, broad, rounded, erect-spreading: stamens about equaling the corolla, the filaments slender, the light-yellow anthers about 1.25 mm. long, coherent in pairs, the cells parallel, truncate at apex, cordate at base: ovary broadly ovoid: style stoutish, 1 cm. long, the stigma dilated, concave: disk of 3 oblong small glands.

Mapiri, 2500 ft., May, 1886 (no. 2422).

This species varies greatly from the genus in the form of its stigma, more like that of *Gesnera*, and in the absence of two lobes of the disk.

Kohlerianthus Fritschii (Rusby) Fritsch, Pflanzenfam., Nacht. 300. Yungas, 6000 ft., 1885 (no. 2438).

Alloplectus dichrons DC. Prod. **7**: 546? Mapiri, 2500 and 5000 ft., Apr. and May, 1886 (nos. 2484 and 2700). Both specimens are very imperfect. They are the same as Spruce's no. 185, placed under *A. Patrisii* in Herb. Kew.

DIPLOLEGNON gen. nov.

Calyx free, laterally compressed, gibbous, colored, 5-parted, the segments ample, unequal, entire, the margins of the lower replicate. Corolla-tube cylindraceous, the base oblique, the mouth slightly contracted, the limb very short, 2 of the lobes erect, rounded, enclosing the other three, which form an inner cartilaginous-thickened series, their apices strongly induplicate. Filaments dilated below, monadelphous and adnate to the corolla at the base, the anthers coherent in pairs, the cells parallel, distinct; staminodium not apparent. Disk of two large glands, the anterior somewhat smaller. Ovary superior, ovoid, the style shorter than the corolla, stout, sigmoid-curved, the stigma large, strongly 2-lobed. Suffruticose, tomentose, the leaves opposite, nearly equal, the flowers fascicled in the axils. Plant having the habit of *Alloplectus*, to which it is closely related.

Name in allusion to the double rim or margin of the corolla.

Diplolegnon Riceanum sp. n.

Densely short-velutinous, the upper leaf-surfaces scabrous; stems (only the uppermost portions seen) light-brown, stout, coarse and weak: petioles 2 to 4 cm. long, very stout; blades 1.25 to 2.25 dm. long, 5 to 8 cm. broad, oblong to ovate: blunt at the base, very short-pointed and acute at the apex, finely and very shortly serrate, thickish but flaccid, dark-green above, ferruginous underneath, the venation lightly prominent on both sides, rather more so above, the midrib and 12 to 14 pairs of slightly ascending secondaries coarse and broad: pedicels .5 to 1 cm. long, very stout, nerved: calyx nearly 2 cm. long, purple, strongly nerved, parted nearly to the base, the lower lobe keeled, its edges strongly reflexed, all broadly ovate, acute, hirsute: disk of two scutellate lobes, thick and fleshy: ovary 5 mm. long, ovoid, compressed: style 1 cm. long, the stigma 3 mm. broad: corolla 2.5 cm. long, 1 cm. broad, thick, red, hirsute, a little broadened upward: stamens about equaling the corolla, the blackish connectives greatly enlarged.

Yungas, 6000 ft., 1885 (no. 2152).

Species dedicated to Dr. Charles Rice, Chairman of the Revision Committee of the U. S. Pharmacopoeia, who has kindly suggested the generic name.

Alloplectus grandifolius Britton, sp. nov.

Ferruginous-tomentose, the upper leaf-surfaces coarsely strigose: stems very stout, weak: only the uppermost leaves seen: the petioles 3–5 cm. long, very broad, the blades 2–3 dm. long, 1–1.5 dm. broad, oval, varying to ovate or obovate, blunt or rounded at the base, obtuse at the apex, thin, dark-green and rough above, with the venation scarcely prominent, deep-purple underneath, with the very broad, coarse midrib and 10–12 pairs of coarse, moderately upcurved secondaries prominent, the margin irregularly serrate-dentate: pedicels 2 or 3 cm. long, stout, weak: calyx deep-purple, 2 cm. long, divided nearly to the base, the lobes obovate, acutish, coarsely serrate-dentate, strongly veined: ovary 5 mm. long and about as broad, strongly and sharply ridged, hirsute when young: style 2 cm. long, pilose: one lobe of the disk prominent, ovate, rounded at the apex, the others inconspicuous and very irregular: corolla not seen.

Mapiri, 2500 ft., May, 1886 (no. 2483).

Columnea Boliviana Britton ex-Rusby, Mem. Torr. Club, **4**: 238. Yungas, 4000 ft., 1885 (no. 1352), 6000 ft. (no. 2487) and Mapiri, 2500 ft., May, 1886 (no. 2488).

Columnea sp. Yungas, 6000 ft., 1885 (no. 2153).

Besleria montana Britton ex-Rusby, Mem. Torr. Club, **4**: 240. Yungas, 6000 ft., 1885 (nos. 2150 and 2425). The same as Spruce's no. 4564 from Tarapota, *fide* Britton.

Besleria Sprucei Britton, sp. nov.

Stems ascending, weak, very coarsely angled, hirsute with spreading yellowish hairs, the internodes 5 or 6 cm. long, only the upper seen: petioles 1–3 cm. long, coarse and broad: blades 1–2 dm. long, 6–8 cm. broad, obovoid, inaequilateral, acuminate at the base, abruptly and acutely short-pointed, finely and sharply serrate, coarsely strigose, very pale underneath, the midrib coarse and broad, the secondaries 10 to 12 pairs, strongly incurved; peduncles 1.5–2 cm. long, 5–7-flowered: pedicels about 1 cm. long, thickened upward: calyx-tube short-crateriform, the lobes about 3–5 mm. long, triangular, ovate, acute: corolla 1–1.5 cm. long, the tube lightly contracted at about the middle, abruptly ventricose above, the lobes short, broad spreading: anthers semi-circular, the connective broad, dark, concave: ovary 4 mm. long, stout style 1 cm. long, both pilose, especially the former: disk cupulate, 1 mm. long, the margin entire or very slightly sinuately lobed.

Mapiri, Bolivia, 2500 ft., May, 1885; grows in deep woods (no. 2149). The same as Bang's no. 2537 and 2538.

Besleria pauciflora sp. nov.

Coarsely pilose, the youngest portions somewhat ferruginous-tomentose: stems stout, weak, coarsely quadrangular, the internodes about 5 cm. long: petioles 3–5 cm. long, tomentose: blades 1–1.5 dm. long, 5–7.5 cm. broad, oval, very abruptly contracted into the petiole, distantly short-serrate, thin, deep-green and sparsely pilose above, pale and pubescent underneath, with the midrib and about 8 pairs of secondaries lightly prominent: peduncles 1 to few-flowered, about 5 cm. long, erect, slender: calyx about 1 cm. long, the tube sub-hemispherical, the lobes lance-ovate, acuminate and acute: corolla light-red, nearly 2 cm. long, the tube ventricose above the middle, the lobes about 2 mm. long, broad, rounded, strongly reflexed: anthers cordate, 1 mm. long, 1.5 cm. broad, with a broad, dark connective: style 1 cm. long, stout, flattened, thickened upward: stigma nearly as broad as the anthers, strongly 2-lobed: ovary 5 mm. long, broadly ovoid: disk very short, interrupted upon one side to form 2 small lobes, the remainder inclined to be 3-lobed.

Mapiri, 2500 ft., May, 1886 (no. 2437).

New Plants from Wyoming.—XI

By Aven Nelson

Potentilla Wyomingensis

Root deep set and woody: caudex densely caespitose; its branches thick and closely covered with brown scales (the remains of old leaves): stems numerous, bearing 1–3 small leaves, pubescent, 1.5–2.5 dm. high: leaves crowded on the crown, silky pubescent, more sparsely so on the upper surface, usually some of them glabrate, pinnate, 5–10 cm. long: leaflets 13–19, irregularly disposed on the channelled rachis and with smaller oblong-linear ones interspersed, crowded toward the apex, the lower 3–5-fid, the upper with more numerous pinnate segments, the segments oblong to linear: cyme irregular, open, 3–9-flowered, rarely 13; pedicels spreading, 1–4 cm. long: hypanthium hirsute, in fruit 5–7 mm. in diameter: bractlets small, oblong-linear, much shorter than the ovate-lanceolate sepals: petals yellow, very broadly obovate, retusely truncate at summit: stamens 20: pistils 15–20.

This species belongs to the section Multijugae and finds its affinity with *P. pinnatisecta* (Wats.) Aven Nelson, though it is a much larger plant with more numerous and much more finely dissected leaflets and more spreading habit. It is sub-alpine while *P. pinnatisecta* is distinctly alpine.

First collected in fruit only, on a grassy north slope near the highest summits of the Seminole Mountains, by Elias Nelson, July 21, 1898, no. 4916. Better specimens secured by the writer in an exactly similar location on Druid Peak, in the Yellowstone Park, July 12, 1899, no. 5781, may be cited as typical of this species.

Potentilla jucunda

Stems usually several, green, obscurely appressed-pubescent rather slender, nearly erect, simple except for the corymbosely-branched, open cyme: stipules lanceolate, acute, entire; basal leaves several to many, digitately 5–7-foliate, greatly variable in size, on slender petioles, 5–20 cm. long; leaflets 4–7 cm. long, from narrowly obovate to oblanceolate, coarsely serrate, the teeth extending nearly half way to the midrib, green on both sides, nearly glabrous above, lightly pubescent beneath: stem leaves smaller and shorter petioled, the uppermost sessile with narrow

leaflets: cyme many-flowered, loose and open: hypanthium softly pubescent, in fruit 1 cm. in diameter: bractlets linear-lanceolate, a little shorter than the broadly lanceolate sepals: corolla large: petals broadly obcordate, 8–10 mm. long, distinctly surpassing the bracts and sepals.

This member of the *Graciles* section is to be compared with *P. etomentosa* Ryd. It is separated from that by its slender habit, differences in leaflets, in bracts and pubescence, and by larger flowers with petals decidedly surpassing the sepals. In some respects it suggests *P. dissecta glaucophylla*, but is a much larger and more nearly erect plant. Collections of it are Green Top, June 28, 1897, no. 3223*a*, and Pole Creek, July 22, 1897, no. 3420, both localities in the Laramie Hills.

Erigeron luteus

Densely tufted on a multicipital caudex: leaves closely crowded on the crowns, all narrowly linear with slightly tapering, petiole-like base, sub-cinereous with a minute pubescence, 3–5 cm. long: stems monocephalous, simple, one only from each crown, scape-like but bearing 2 or more short leaves below, these obscured by the numerous, fascicled crown leaves, the peduncular portion usually with one small bract, from barely exceeding the leaves to about twice as long: heads 6–8 mm. high, the involucral bracts linear, acutish, somewhat unequal and in two rows, rather shorter than the disk: rays 30–40, a pure yellow, rather broad and short, the ligule only 3–4 mm. long: pappus in two series, the outer of very short, inconspicuous bristles; the inner bristles rather sparse and coarse, nearly as long as the tube of the disk corollas: akenes minutely pubescent.

A distinctly yellow *Erigeron* is somewhat anomalous. Two collections of this show it constantly and strikingly so. It is true that Dr. Gray, in Syn. Fl. 213, admits some pure yellow forms into his *E. peucephyllus* but those are admitted into that species as exceptions. The localities and colors as there given would lead one to believe that the original of that species had pale blue rays and came from British Columbia. This in connection with the fact that *E. peucephyllus* is a larger plant, with coarser and much taller and more leafy stems, with sometimes 2–3 heads, coarser pubescence, larger and fewer rays, etc., leads me to think that these yellow Rocky Mountain forms may best stand as a species. The characterization of *E. peucephyllus* as densely caespitose on

the enlarged crown of the caudex would be thoroughly diagnostic, but *E. luteus* has a caudex that is itself much branched and caespitose.

Collected on a stony, gravelly hillside near Junction Butte, no. 5741, and on gravelly bars on Soda Butte Creek, no. 5852; both from Yellowstone Park, July 9, 1899.

Artemisia rhizomata

Perennial from rather slender, horizontal, semi-woody rhizomes, white or grayish tomentose throughout: stems rather numerous, slender, ascending or nearly erect, simple but for short foliose shoots in the axils of the leaves: leaves entire (rarely incised), linear-oblong to lanceolate, 2–4 cm. long: those of the short axillary shoots crowded and much smaller, only 1–2 cm. long: inflorescence paniculate, consisting of a succession of axillary, spike-like, nearly simple racemes which are crowded and naked above, the lower axillary shoots mostly sterile but sometimes all floriferous: heads oval or campanulate, about 4 mm. high and 20 flowered, of which nearly half are female, some of the disk flowers apparently not maturing akenes: akenes oblong, smooth, about 1.5 mm. long.

The only species in this range with which this is comparable is *A. Ludovicana*, but the habit and leaf characters, and its rather unusual inflorescence, clearly separate it. Its rhizomes, too, are peculiar. *A. Ludoviciana* occurs on dry ravine banks among the hills, while this is found on low saline flats adjacent to streams. First collected on the Sweetwater, Sept. 9, 1894, no. 1181, and distributed as *A. Mexicana* Willd., though to this it bears little resemblance. Since collected at Laramie also.

Artemisia rhizomata pabularis

More slender than the species with more numerous, erect stems: the more slender rhizomes freely spreading just below the surface of the soil: leaves crowded, nearly linear, more or less incisely toothed at apex, 3–5 cm. long: the axillary, spicate flower clusters shorter and more crowded: flowers fewer (about 15) nearly all hermaphrodite.

This is probably a good species, but as I have but one collection of it, it may stand as a variety until it has again been studied in the field. It was secured in the Red Desert, near Creston, Aug. 29, 1897, no. 4426, in a saline draw, where it was growing freely

intermingled with the grasses (*Agropyron* sp.). In a region in which the *Artemisias* constitute an appreciable part of the forage, it would seem that this must be the best, whether as winter feed on the ground or cut and cured with the grasses.

Artemisia paucicephala

Tufted and matted, the long, woody rhizomes intricately interlaced and bearing numerous, fibrous roots: thinly but permanently silvery-tomentose throughout: stems numerous, leafy to the summit, erect, simple or sparingly branched, 2–4 dm. high: leaves 4–8 cm. long, mostly entire, linear to lanceolate, some with a broad, 3–5-cleft apex, nearly all with a narrowed, petiole-like base, only a few of the uppermost reduced and bract-like: heads few, racemosely disposed on the main stem and its slender branches (if any), rather large, sessile or short pedicelled, broadly campanulate, about 5 mm. in diameter (40–60 flowered); involucral bracts oval or ovate, scarious margined: the pistillate flowers few, very slender, with linear-clavate styles; the hermaphrodite with spreading recurved styles and penicillate stigmas protruded between the lobes of the corolla: corolla sparsely resinous dotted, mainly on the tube.

This has affinities with both *A. Ludoviciana* Nutt. and *A. Natronensis* Aven Nelson but may at once be distinguished by its tufted caespitose habit, its low, erect stems, its different leaves and few, many-flowered heads.

Collected near Yellowstone Lake, on the banks of a tributary creek, where occasional mats of it were to be found; no. 6344, Aug. 6, 1899.

Artemisia gracilenta

Tufted perennial, from a deep-set caudex whose numerous branches are spreading-rhizomatous and give rise to numerous, fibrous roots: white tomentose throughout: stems herbaceous, slender, strict, erect, 4–8 dm. high: leaves numerous, sessile by a narrow base, 3–5 cm. long, pinnately parted; the 5 or more divisions linear, widely divergent and often more or less cleft towards the apex, 1–2 cm. long; the lower bracts similar but smaller, gradually passing into the small, linear, entire ones of the summit: inflorescence spicate-axillary, the rather large heads produced singly, or sometimes more crowded, the inflorescence then tending to become thyrsoid-paniculate with smaller heads: heads broadly campanulate, 5–7 mm. high and nearly as broad, sessile or on rather stout pedicels 1–several mm. long, these erect or only

slightly recurved; the involucral bract short, oblong-ovate: the flowers (30–60), all fertil, the pistillate few, with exserted, recurved styles, the hermaphodite with short, included, cleft style: the stigmas truncate, penicillate: the corollas resinous dotted throughout.

This *Artemisia* does not seem to be closely allied to any of the known Rocky Mountain species, but in some respects at least it is allied to *A. Ludoviciana* Nutt. Its silvery-white aspect, numerous, slender, erect stems, narrow leaf segments and many-flowered heads are characteristic. Seemingly rare: only a few clumps of it observed on the sandy beaches and banks of Yellowstone Lake. Type number, 6612, Aug. 22, 1899.

Artemisia subglabra

Herbaceous perennial, the tufted stems rather few, erect-ascending, slender, more or less branched above, very obscurely glandular-pruinose, otherwise green and glabrous as are also the leaves, 3–5 dm. high: leaves pinnate or bi-pinnate; the segments linear or sometimes broader, widely divaricate, the margins more or less revolute: inflorescence racemiform or narrowly paniculate; the heads medium size (3–5 mm.), shortly pedicelled, spreading or deflexed; the involucral bracts green, oblong, with ciliate-lanate margins: flowers 12–20, all fertile, the pistillate with flattened or grooved spatulate styles.

In general aspect somewhat suggesting *A. dracunculoides* but wholly different in floral characters, in which it more closely approaches *A. incompacta* Nutt. It was secured on the stony banks of Yellowstone River, near Yancey's, Yellowstone Park, July 9, 1899, no. 5743.

The Crystals in Datura Stramonium L.*

By Henry Kraemer

The value of the study of the distribution of crystals of calcium oxalate in plants from a systematic standpoint has been demonstrated by R. V. Weltstein in an exhaustive study of the members of the family Umbelliferae. In some, if not all of the members of the family Solanaceae, are to be found in one or more elements (root, stem, leaf, etc.) cryptocrystalline crystals of calcium oxalate. These are also referred to by different writers as "Sable tetraédrique" or as "Krystallsand." In the genera *Atropa* and *Solanum* these crystals occur uniformly in some of the parenchyma cells of roots, stems and leaves. In some other genera, as in *Hyoscyamus*, these cryptocrystalline crystals may be replaced for the most part by monoclinic prisms or pyramids and in still other genera, as in *Datura Stramonium* L., by rosette aggregates and other crystals. The form of the crystals as well as their distribution in the members of the family Solanaceae will, no doubt, prove of significance in the developmental history of the genera comprising this order. In the root of *Datura Stramonium* L., we find in the parenchyma of the primary cortex, numerous cells which possess a very large number of small cryptocrystalline crystals of calcium oxalate which are more or less deltoid in shape and from 2–10 μ in their longest diameter. On account of the small size of these crystals there are likely to be some differences of opinion as to which system they belong. Vesque describes them as "Sable tetraédrique," indicating that they are hemiedral forms of the isometric system. But inasmuch as calcium oxalate crystals are only known to occur in the monoclinic or tetragonal systems it seems that they are probably hemiedral forms of either one or the other of these systems. It would appear that part of the crystal was formed and that the formation of the remaining part was either interrupted or disturbed. It is not at all unlikely that further investigations will demonstrate that they are hemiedral forms of the

* Presented at the Columbus Meeting of the American Association for the Advance- of Science.

monoclinic system. Instead of the crystals having a true deltoid form like a tetrahedron, one axis is frequently as much as twice as long as the other two axes. It may be mentioned that it is not unusual to find associated with these hemiedral forms crystals which resemble the octahedrons or hexahedrons of the isometric system, but the greater difference in the length of one axis indicates that they are either prisms or octahedrons of the monoclinic system. In the stem we find the same kind of crystals as well as a similar distribution of them that we noted in the root. The crystals may in some cases be larger, measuring as much as 15 μ in their longest axis. There are also present in some of the cells monoclinic prisms (about 20 × 5 × 5 μ) as well as rosette aggregates made up of about 12 of these prisms. In some specimens these prisms are replaced by acicular crystals (35 μ long) which may be united or aggregated to form large sphere crystals.

In the petiole of the leaf we find numerous hemiedral cryptocrystalline crystals (20 × 10 × 10 μ). There are, however, in addition many monoclinic prisms (14 × 10 × 10 μ) or pyramids (25 × 10 × 10 μ) or a few rosette aggregates of crystals (30 μ in diameter). In some specimens the hemiedral forms may be largely replaced by monoclinic prisms (15 × 4 × 4 μ) or pyramids (10 × 3 × 3 μ) or acicular crystals (35 μ in length). In the parenchyma of the nerves of the lamina there are many cells that possess cryptocrystalline crystals, but we also find large monoclinic pyramids (28 × 15 × 15 μ) and rosette aggregates (28 μ in diameter). There are also present in some specimens numerous small prisms and acicular crystals.

In the mesophyll of the leaf the cryptocrystalline crystals are entirely replaced by rosette aggregates (17 to 24 μ in diameter): one occurring in each parenchyma cell directly below the palisade layer.

In the parenchyma of the flower stalk we find very small rosette aggregates of crystals (10 μ in diameter). In the parenchyma of the calyx a few small prisms (1–3 μ long) and rosette aggregates (10–14 μ in diameter) are found.

In the parenchyma of the corolla are small prisms (2–3 μ long) and some small rosette aggregates. In the filaments of the stamens there are some exceedingly small cryptocrystalline crystals.

In the ovary a very large number of the cells contain cryptocrystalline crystals ($2 \times 1 \times 1\ \mu$) and in the region of the placenta or inner epidermis rosette aggregates ($14\ \mu$ in diameter) may be found.

It is rather interesting to note that the cryptocrystalline crystals which are found in such abundance in the parenchyma of roots and stems of *Datura Stramonium* L. are replaced in part in the petiole and nerves of the leaves by prisms, pyramids and rosette aggregates of crystals and that in the lamina the prisms and pyramids evidently are united to form rosette-shaped aggregates only.

Not infrequently do we find in a cell containing cryptocrystalline crystals a large rosette-shaped mass of what appears to be an aggregate of small hemiedral crystals.

The fact that we find monoclinic prisms in *Hyoscyamus* and raphides in some instances in *Atropa* and *Solanum* is further indicative that all the various forms of crystals in *Datura Stramonium* L. are likewise of the monoclinic system.

That there is a close relationship between the different genera of the family Solanaceae is evidenced by the observations that some of the parenchyma cells of some of the elements of nearly all of the genera and species appear to contain hemiedral cryptocrystalline crystals. These are contained uniformly and in greatest amount in the genera of the Solaneae and Datureae and to the least extent in some of the genera of the Cestreae and Salphiglossideae, there being some exceptions to the last groups in *Vestia* (of the Cestreae) and *Anthocercis* (of the Salphiglossideae).

Proceedings of the Club

WEDNESDAY EVENING, OCTOBER 25, 1899

Vice-President T. F. Allen in the chair; 38 persons present.

One resignation was offered, that of Mr. Edward B. Miller, now permanently removed to Woodland, Ulster Co. On motion of Dr. Britton this resignation was accepted and the name transferred to the list of corresponding members.

The scientific program opened with a paper by Dr. D. T. MacDougal on "The Mycorhiza of *Cephalanthera*," describing the general characters of this Pacific coast plant, with special reference to its symbiotism, and exhibition of specimens in alcohol. Dr. MacDougal's specimens form probably the most complete examples of its root system ever procured, the plant growing among matted hemlock roots and very difficult to get at. Discussion by Dr. Britton of the taxonomic relations of *Cephalanthera* followed.

The second subject of the evening was "Notes on Ferns," presented by Mrs. Britton, with specimens and lantern views. Among other interesting plants exhibited were some very large examples of *Botrychium lanceolatum*, from the foot of Mt. Rainier, about a foot high, including roots, and with the lamina nearly three inches in length.

Mr. W. N. Clute spoke of finding *Dryopteris Goldieana* at Bedford Park, and of continued discoveries of *Dryopteris simulata*, usually in company with *Woodwardia areolata*.

Mrs. Britton spoke of the association of *Dryopteris simulata* on the Pocono with *Rhododendron maximum*, in very different surroundings, and called attention to its distinctly blue-green coloring.

Mr. Clute reported a new station for *Schizaea pusilla* at Allen's Bridge, N. J., on the east branch of the Wading River, in quantity, observed last July. The sporophylls of last year were then still remaining on the plant. Sterile leaves were coiling about neighboring stems as if with a trace of the climbing habit of its relative *Lygodium*. This coiling tendency has occasioned the name of curly-grass, which was found in use in New Jersey for *Schizaea*.

The Secretary referred to the successful transplanting of *Schizaea* into a locality near Lakewood, N. J., by Miss R. W. Farrington.

The Secretary made some remarks upon singularities in the distribution of *Aster Schreberi*, a species described by Nees in 1818 from a single plant, and afterward omitted by botanists, until the publication of the Illustrated Flora. The abundance of this species, which he finds characteristic of the Schoharie drainage-basin of the Catskills, contrasts strangely with its absence from other parts of that region.

Judge Brown reported finding *Solidago odora* on high ground near Sam's Point late in the season, many scattered plants appearing in flower at about 2000 ft. altitude.

Dr. Britton remarked that this forms an interesting addition to the number of coast plants found in the Shawangunk range. It has been claimed that the breaking up of sandstone rocks there has produced a sandy soil sufficiently similar to that of the seashore to permit the growth of certain arenophilous plants usually found only on the coast.

Mr. R. S. Williams, of Montana, recently returned from the Klondike, spoke of the forests there, of the use of the paper birch for fuel, and of the numerous shrubs, a small *Amelanchier*, etc. Strawberry blossoms were abundant. A yellow-berried raspberry occurs, from which the Indians prepare a drink. Mosses were abundant, covering swamps, becoming dry in the latter part of the season, and ready to burn. The more moist parts of the land never thaw more than 15 inches below the surface. One party put down a shaft 130 feet through frozen gravel, and then reached unfrozen gravel, through which the shaft was continued 60 feet further.

Dr. T. F. Allen spoke of a specimen of *Rhus vernicifera*, the lacquer tree of Japan, which is growing luxuriantly on his lawn in Connecticut. It resembles our swamp sumach, *Rhus venenata*, in appearance, and is becoming a handsome tree. Some of his family who are sensitive to *Rhus* poisoning, find it necessary to avoid going near it.

Discussion followed regarding localities for *Rhus typhina* near New York. Dr. Britton mentioned its occurrence in several lo-

calities on the Palisades and in the mountains in New Jersey. Miss Ingersoll mentioned Ulster county, Mrs. Britton, High Bridge within the city, and the Secretary stated that he had recently observed it at Alpine, N. J., in considerable quantity. Dr. Britton alluded to its desirable qualities as an ornamental tree, improving greatly in cultivation, as may be seen at the Botanical Garden.

Dr. Britton also reported a gift to the Botanical Garden of about 200 volumes which had belonged to the botanist, David Hosack. They are in excellent condition and some of them extremely rare.

Adjournment followed.

TUESDAY EVENING, NOV. 14, 1899

Dr. Rusby in the chair; 29 persons present.

Two new members were elected: Miss Carrie Huse, 223 West 23d Street, Mrs. Wm. E. Damon, of the same address, both proposed by Miss Murray.

The scientific program consisted of a paper by Mrs. C. L. Pollard on "Types of Vegetation on the Florida Keys," illustrated by the lantern. Mr. Pollard described the successive steps in the formation of those islands, and distinguished their belts of mangrove and occasionally of fine littoral flora, with interior zones known as "scrub-hammock" and "tall-hammock," and with pine-barrens, and salt-barrens. He ascribed the flora to a West Indian origin, and remarked also upon the chief fruits and garden plants cultivated, and the weeds of the gardens. Beautiful views were exhibited, showing the *Casuarina*, much planted in Key West, competing there with the cocoanut palm as a shade-tree; *Tillandsias* in the scrub-hammock each holding a quart of water among its leaf-bases, even on the driest day, etc. Among the most interesting views were those showing the development of an island originated by a single mangrove-tree. The mangrove seedlings drop like a plummot through the water into the mud, and may be washed a little way by the tide, but as the tidal force is small, it is very rare that a mangrove seedling dies, and there is little chance of its failing to strike root promptly, except when it happens, rarely, to strike upon a coral rock.

Dr. Rusby alluded to the mangrove roots as an important source for tannin.

Mr. Lighthipe spoke of the fragrance which he finds characterizes *Tillandsia usneoides* at the time of flowering. Around Jacksonville this is now growing scarce in consequence of its extensive collection to manufacture "mohair" for mattresses.

WEDNESDAY EVENING, NOVEMBER 29, 1899

Fifty-two persons present; President Brown in the chair.

Attention of the Club was called to the Card Index of Current American Literature, hitherto published by the Cambridge Botanical Supply Company, and it was moved and carried that the Card Index be contined under the auspices of the Torrey Club. It is prepared by the editors of the BULLETIN, and it would seem proper that the distribution of the Index be under their control. It is understood that the passage of this motion will not expose the Club to financial responsibility.

Dr. Britton raised the question of continuance of field excursions through the winter, for study of bryophytes, algae, etc.; the reports from the November excursions warranted their continuation, and the Club voted that the Committee be requested to continue the excursions until further action.

Two new members were elected: Miss Louise B. Dunn, assistant, Barnard College; Mr. David Griffiths, Columbia University. Both proposed by Professor Underwood.

The scientific program consisted of a paper by Dr. C. C. Curtis, on the algae, with lantern views illustrating the leading families, and with a condensed summary of the modes of reproduction and other characteristics of each. Dr. Curtis also gave brief directions respecting methods of collecting and preserving the marine algae, urging the collector to make microscopic study of all forms, and pointing out the great need of further observation to clear up doubtful points in their reproductive processes.

President Brown exhibited specimens found by Dr. Meredith at Danville, Pa., of *Ajuga Genevensis* and of *Hieracium Pilosella*. The first had been observed on ballast in New York City, but not the latter.

EDWARD S. BURGESS,
Secretary.

Index to recent Literature relating to American Botany

This Index is intended to include (1) Titles of all papers and books relating to American plants; (2) All papers on botanical subjects by American botanists; (3) Papers of special interest relating to physiological or morphological subjects wherever published. Botanists can aid greatly in this matter by the contribution of separates of their papers especially those published outside the usual botanical journals, such as the publications of learned societies, experiment station bulletins and reports, and journals only occasionally containing botanical matter.

The titles are reprinted monthly on standard library cards of two widths, and are sold to subscribers at the price of one cent per card.

The editors will welcome any notice of omitted titles or other suggestions relative to the greater efficiency of the Index. Address all matters relating to the Index to The Torrey Botanical Club, Columbia University, New York City.

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Ashe, W. W. Contributions from my Herbarium. Bot. Gaz. **28**: 270–272. 21 N. 1899.

Crataegus Sauratonae sp. nov., and *Crataegus Chapmani* (Beadle) nom. nov.

Bicknell, E. P. Studies in Sisyrinchium—VI: Additional new Species from the Southern States. Bull. Torr. Club, **26**: 605–616. 22 D. 1899.

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Volutella mellea Clark.

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Coulter, S. Notes on the Germination and Seedlings of certain native Plants. Proc. Indiana Acad. Sci. 1898: 215–222. 1899.

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Dickson, J. M. *Trillium grandiflorum* Salisb. Jour. and Proc. Hamilton Assoc. **15**: 99. 1899.

Notes on the green-flowered forms.

Dietel, P. Uredineae brasilienses a cl. E. Ule lectae. II. Hedwigia, **38**: 248–259. 10 O. 1899.

New species in *Uromyces*, *Puccinia*, *Diorchidium*, *Ravenelia*, *Anthomyces* nov. gen., *Didymospora*, nov. gen., *Uredo* and *Aecidium*.

Earle, F. S. Some Fungi from South America. Bull. Torr. Club, **26**: 632–634. 22 D. 1899.

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Fairchild, D. G. Notes on Travel—II. Payta and the Desert Region of Peru. Bot. Gaz. **28**: 203–207. 25 S. 1899.

Fernald, M. L. *Ranunculus acris* var. *Steveni*, in New England. Rhodora, **1**: 227–229. D. 1899.

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List of 527 species with their distribution.

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New species in *Argemone, Lesquerella, Aragallus, Solidago, Eucephalus, Machaeranthera* and *Bidens.*

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New species in *Chaenactis, Machaeranthera, Leucelene, Solidago, Polemonium, Gerardia* and *Orthocarpus.*

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Greene, E. L. West American Asperifoliae—IV. Pittonia, **4**: 86–97. 8 D. 1899.

New species in *Mertensia, Lithospermum, Oreocarya,* and *Lappula.*

Griffiths, D. *Anthurus borealis* Burt. Bull. Torr. Club, **26**: 628–631. 22 D. 1899. [Illust.]

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